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Geothermal Energy in Northern Canada: Recent Advances and Future Prospects for Community-Driven Research and Development

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ABSTRACT

Remote communities across northern Canada are increasingly integrating renewable resources into their energy systems. Across Yukon, Northwest Territories, Nunavut, and Nunavik, most communities' energy needs are met by fossil fuels. The shift towards renewable energies is driven by communities with goals to reduce greenhouse gas emissions, lower energy costs, and enhance energy sovereignty and security. In northern Canada, geothermal research has previously focused on resource and technology assessment. Shallow resources can provide short-term alternatives to meet energy needs at the building-scale, whereas deep resources are associated to higher-risks and long-term developments but could meet community-scale heating demand. For example, recent research in Baker Lake, Nunavut, explored the potential for both borehole heat exchangers and enhanced geothermal systems. Recently, fundamental research has been complemented by applied projects aligned with community interests. Innovative projects like a shallow open loop system to pre-heat domestic water in Mayo, Yukon, and a pilot ground-coupled heat pump system in Kuujjuaq, Nunavik, are demonstrating the feasibility of geothermal heating in northern climates. This manuscript summarizes the advancements of geothermal research and developments across northern Canada. It also identifies opportunities for collaboration across disciplines that would allow projects to be better adapted to local conditions. This could include the integration of geothermal energy with other renewable energy sources or in district heating systems. It also highlights pathways for future research and considerations to ensure project development is aligned with community visions and the local geological potential.

1 INTRODUCTION

Canada has 51 off-grid northern communities (above 55º N). These communities are in the Yukon, Northwest Territories, Nunavut, and Nunavik. Diesel is the main power source in each of these communities, except for Kawawachikamach and Inukjuak, Nunavik, which benefit from hydroelectricity. In most remote communities, power is provided through a micro-grid supplied with a diesel-fired thermal plant, and space heating is achieved with a combination of diesel and wood or biomass (Miranda et al., 2020).

Many of these communities have started to integrate local and renewable energy sources into their energy systems (Arriaga et al., 2017). Wind and solar electricity have been at the forefront of these community efforts. For example, Kluane First Nation (Burwash Landing, Yukon) installed a 900-kW wind turbine that was connected to their micro-grid in 2024. The wind, combined with a battery storage, is expected to reduce the prior diesel plant's consumption by 50% (Natural Resources Canada, 2025). Chief Dickson emphasized that this project exemplifies Kluane First Nation's respect for the land while increasing self-reliance (Natural Resources Canada, 2025).

While wind energy projects like Kluane's mark a major step toward renewable integration, geothermal energy offers a complementary solution particularly suited to fulfill heating needs. The Department of Energy, Mines and Resources completed much of the early geothermal research in Canada through The Geothermal Energy Program (1976 to 1986). This research primarily focused on heat flow and heat generation. Fundamental research around geothermal potential in northern Canada expanded as of the 2010s. This research has primarily been undertaken by research groups at the federal and territorial Geological Surveys and Canadian universities. Miranda et al. (2022) provide a broad overview of deep geothermal potential of northern Canada and geothermal technologies for northern communities.

From 2023 to 2025, researchers from Université du Québec en Outaouais and the Institut national de la recherche scientifique (INRS) evaluated the social acceptability of geothermal energy across three northern communities: Burwash Landing, Yukon; Fort Simpson, Northwest territories; and Kuujjuaq, Nunavik (Friser et al., 2024). Feedback from this research highlighted a desire for a better understanding of geothermal energy and a shift from fundamental research to the development of pilot projects.

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The objective of this review is to summarize recent advancements in geothermal research and development in northern Canada, highlight pilot projects and identify key opportunities for interdisciplinary collaboration. Future pathways to align projects with geological potential and community interests are outlined. Focus is on the Canadian northern territories with most off-grid communities although additional indigenous-led projects are taking place outside of this region, for example the Tu Deh-Kah project in Fort Nelson, Northern British Columbia.

2 OVERVIEW OF GEOTHERMAL RESEARCH IN NORTHERN CANADA

2.1 Nunavik

Fundamental research into the geothermal potential in Nunavik dates back to 2015 (Majorowicz & Minea, 2015). Gunawan et al. (2021) conducted a detailed life cycle cost analysis of shallow geothermal systems in Kuujjuaq, showing that uncertainties in subsurface thermal properties can significantly affect system design and performance projections. Temperature profiles and thermal conductivity have been measured across four shallow- to moderately deep boreholes (>200 m) in Kuujjuaq. Gradients ranged from 9 ºC/km to 21 ºC/km and heat flux ranged from 26 to 57 mW/m^2 (Comeau et al., 2017; Majorowicz & Minea, 2015; Miranda & Raymond, 2022). These variations highlight the need for site-specific evaluations to better constrain development potential (Miranda et al., 2022).

Further research concludes that shallow ground-coupled heat pump (GSHP) systems and underground thermal energy storage could address short-term heating needs, whereas deep enhanced geothermal systems may offer long-term solutions (Giordano & Raymond, 2019; Gunawan et al., 2020; Miranda et al., 2020, 2021; Wu et al., 2024). Kuujjuaq remains active in geothermal research and now hosts a pilot ground-source heat pump system operating in a subarctic climate (see section 4.1.).

In Umiujaq, Moreno et al. (2024) assessed the life cycle cost of alternative heating systems for a research station in a subarctic climate. While ground-source heat pumps were technically viable, high electricity and drilling costs limited their economic appeal. However, combining GSHPs with biomass and photovoltaics offers an interesting alternative (Moreno et al., 2024).

2.2 Nunavut

Fundamental geothermal research in Nunavut was initiated by RESPEC in 2018 and focused on mapping heat flow across the territory to identify areas of geothermal favourability (Minnick et al., 2018). The communities of Cambridge Bay and Resolute Bay, located in sedimentary basins, as well as Baker Lake located in the Canadian Shield, were identified as areas of interest. Quilliq Energy Corporation received federal grants to continue geothermal research in these regions supported by RESPEC. Additional geophysical, rock property, and surface geology data were collected for Cambridge Bay and Resolute Bay and a 500 m exploration borehole was drilled in Baker Lake in 2022 (Geothermal Canada, 2023).

A temperature gradient of 28 ºC/km was measured in the exploration borehole and thermal conductivity was measured on core samples (Miranda et al., 2023). This data provided the basis to develop strategies to maximize underground heat storage and minimize impact on permafrost through borehole thermal energy storage systems (Gold et al., 2023). Subsequent research by Miranda et al. (2023) demonstrated that shallow (≤300 m) borehole heat exchangers could be technically and economically feasible when coupled with a water-to-water heat pump.

Bacon et al. (2024) then used the exploration borehole data to further constrain the heat flux at Baker Lake (63 to 77 mW/m^2) and evaluate the deep geothermal potential. A 4 km deep borehole could meet the communities heating demand, but reservoir stimulation would be required to generate enhanced geothermal systems due to the low permeability of the host rock (Bacon et al., 2024). Research supported by the Cascade Institute's Ultradeep Geothermal project advanced the understanding of subsurface permeability (Bacon, 2026). However, further research that integrates geomechanics is essential to confirm permeability and the viability of an enhanced geothermal system in Baker Lake.

Preliminary research is also underway in the Canadian High Arctic with recent fieldwork completed by Natural Resources Canada on Cornwallis Island and in Resolute Bay, Nunavut (S. Grasby, personal communication, 2026).

2.3 Northwest Territories

In 2007, the City of Yellowknife showed interest in the geothermal potential of the flooded Con Mine. This led to the development of a conceptual model for a geothermal district heating system (Ghomshei, 2007). Mandemvo

et al. (2023) conducted an analytical resource assessment for the mine, estimating that a geothermal heat pump system could deliver up to 17,520 MWh/yr for heating and 8,234 MWh/yr for cooling. These values are aligned with a subsequent numerical model which demonstrated that at a flow rate of 0.06 m^3/s, the total energy delivered to buildings would range from 953 MWh to 18,048 MWh at a pump depths of 0.3 km and 1 km, respectively (Mandemvo et al., 2024).

In 2010, the Northern Plains Heat Flow Anomaly (NPHA) was identified as an area of interest for geothermal exploration due to the anomalously high heat flow (EBA Engineering Consultants, 2010). The South Slave administrative region falls within the NPHA which extends across northern Alberta, northwest British Columbia, and into southern Northwest Territories (Majorowicz, 1996). The deep geothermal potential is being evaluated for four communities within the South Slave administrative region (Thibault et al., 2024; Figure 1): Hay River (Xátł'odehchee, K'atlodeeche First Nation and Ts'ueh Nda, West Point First Nation), Fort Providence (Zhahti Kúé, Deh Gáh Got'îê), Enterprise, and Kakisa (K'ágee, Ka'a'gee Tu First Nation).

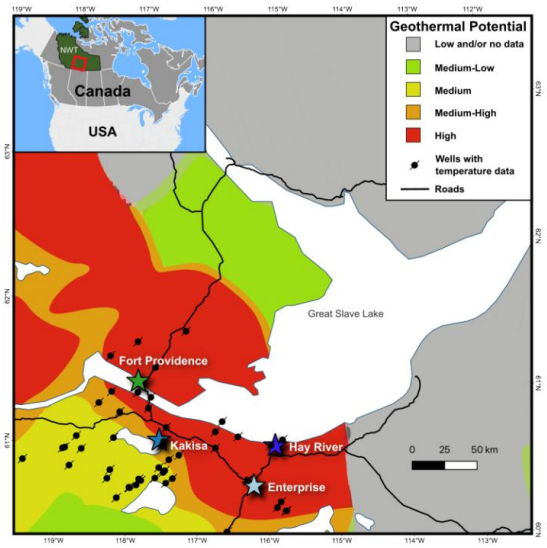


Figure 1: Geothermal potential map based on temperature with communities in the South Slave administrative region indicated by stars (from Thibault et al., 2024).

Recent research evaluated thermophysical properties of the NWT South Slave's sedimentary rocks and generate local 1D temperature models in the sedimentary layers below each community (Rajaobelison et al., 2024). Thibault et al. (2024) followed up on this research by extrapolating temperature into the underlying Precambrian basement rock. Their research concluded that the main heat transfer mechanism is conduction. The geothermal gradient is expected to range approximately from 30 to 60 °C km^{-1}, and the surface heat flux from about 100 to 160 mW m^{-2} (Thibault et al., 2024). Deep borehole heat exchangers or enhanced geothermal systems could therefore be envisioned to exploit the geothermal resources. Current research involves numerical modeling of deep borehole heat exchangers to assess long-term geothermal viability for each community.

Furthermore, the ongoing thermochronological studies in the Liard Basin have advanced the understanding of the regional geothermal history by confining maximum burial temperatures between 140 and >200 °C. This research has also helped in characterizing variability in uplift and cooling (exhumation) associated with Cordilleran tectonics and inherited basement structures (Pinto & Enkelmann, 2025). This ongoing research is a collaborative project with the Northwest Territories Geological Survey, highlighting the structural control of features such as the Wopmay fault zone and the Great Slave shear zone on the basin's cooling and heating patterns. This research is instrumental in expanding the understanding of present-day geothermal gradients and reservoir conditions in the southwestern Northwest Territories.

In parallel, Acho Dene Koe First Nation secured two rounds of funding (Phase 1: 2023, Phase 2: 2024) through the Clean Energy for Rural and Remote Communities Program to assess geothermal potential in Fort Liard. ADK Holdings Ltd. obtained the funding and is conducting the assessment in partnership with the Barkley Group (Natural Resources Canada, 2024).

Natural Resources Canada continue to inventory available geoscience knowledge across communities in the Northwest Territories, as well as in Yukon and Nunavut. A first-order estimation of geothermal potential has been

completed for communities with sufficient geoscience data available, such as Inuvik (S. Grasby, personal communication, 2026).

2.4 Yukon

Yukon is located on the Canadian Cordillera. Accretion of the Canadian Cordillera potentially started as early as the late Permian (Beranek & Mortensen, 2011), was ongoing during the Late Triassic to earliest Jurassic (Colpron et al., 2015; George et al., 2021), and continues today with the collision of the Yakutat microplate (Elliott et al., 2010). This tectonic context contributes to presence of hot springs and radiogenic heat production.

The local First Nations used the Takhini Hot Springs near Whitehorse, Yukon as a meeting place for generations. The hot springs were known as Jim Boss' Bathtub, after the local First Nations Chief. First Nation communities in Yukon were also known to use fire-heated stones to radiate heat around their homes. These hot springs and fire-heated stones are the first recorded use of geothermal energy in Yukon. The Takhini Hot Springs site was purchased in 1902 and has since transitioned to commercial pools. In 2023, Léveillée-Dallaire and Raymond (2023) developed a numerical model to investigate the subsurface characteristics controlling the warm water up flow at Tahkini Hot Springs.

Heat flux evaluations for British Columbia and southern Yukon were measured and catalogued under the federal Geothermal Energy Program with initial heat flux maps published in 1984 (Jessop et al., 1984). Grasby et al. (2012) discuss the sparse heat flux data available for Yukon despite promising geothermal potential based on available data with mean heat flux ranging from 80 to 90 mW/m^2. From 2017 to 2024, further geothermal research and exploration aimed to address this knowledge gap (Chapman et al., 2025; Eavor, 2023; Fraser et al., 2019; Witter et al., 2018). The Yukon Geological Survey inventoried relevant geothermal data across the territory (Sternbergh & Colpron, 2025), which led to the collection of additional temperature gradient and thermal conductivity values from which heat flux could be derived (Miranda et al., 2025). Colpron (2019) also mapped potential radiogenic heat production from granitoid plutons across southern Yukon and then focused in on the Seagull and Teslin plutonic suites (Colpron et al., 2021). In parallel, Witter (2020, 2022, 2023) collected and analysed existing geoscience data to provide an early-stage review of geothermal potential along the Denali fault, Tintina fault, and Teslin fault, respectively. This work is primarily based on geophysics data, including Curie-point depths, and highlights the need for in-situ drilling to better evaluate the geothermal potential at each site. Tschirhart et al. (2022) used 3D inversion of passive electromagnetic data around the Denali fault and identified vertical conductive structures along local faults.

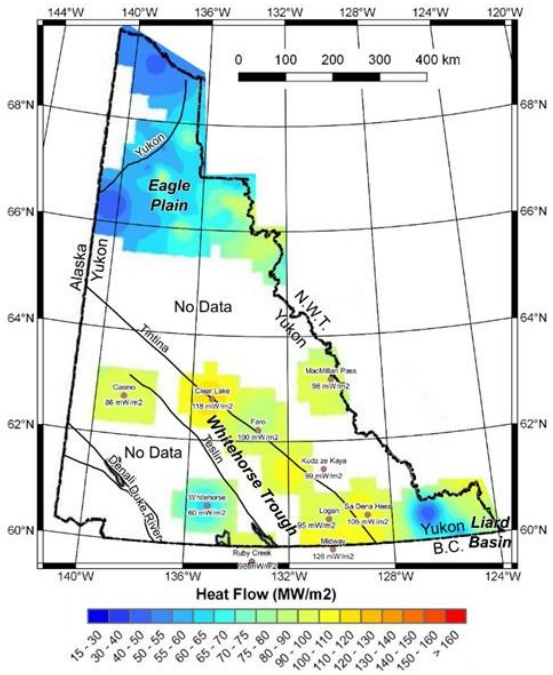


Figure 2: Heat flow map for Yukon (extracted from Grasby et al., 2012).

A 220 m borehole was drilled along the Denali fault in 2023 (Yukon Geological Survey). Chapman et al. (2025) measured the temperature profile and completed a thermal response test in this borehole, as well as in a 387 m borehole drilled by Kluane First Nation in 2012. The borehole data were used to evaluate variations in heat flux around the community of Burwash Landing, and on either side of the Denali fault. Surface heat flux was

estimated at 89 mW/m^2 to the southwest, and 99 mW/m^2 to the northeast (Chapman et al., 2025). The influence of groundwater flow at each borehole was also observed. The resulting heat flux estimates will be integrated into a numerical model with local permeability data (Chapman et al., 2022) to improve the local deep geothermal potential assessment. In turn, shallow geothermal data from the Burwash Landing borehole will be used to inform the development of a small-scale pilot project (section 4.2.4.).

In Whitehorse, Newton (2025) is currently developing temperature and thermal conductivity maps to evaluate the potential of ground-source heat pumps. While territorial heat flux provides guidance for deep geothermal resource exploration for direct use, ground-source heat pumps offer an indirect alternative to use shallow-geothermal resources for space heating and cooling.

As part of its climate and energy strategy, the Government of Yukon is committed to creating a dedicated legislative framework for geothermal energy under Action E11 of Our Clean Future (Yukon Government, 2020). Public engagement in 2022–2023 highlighted key considerations, including royalty structures, aquifer protection, decommissioning protocols, and First Nations consultation (Holm, 2023). The legislation will apply to deep geothermal systems capable of utility-scale heat or electricity generation, while shallow ground-source heat pumps will remain under local building codes.

3 SOCIAL ACCEPTABILITY

Geothermal energy is a local resource that is difficult to export. Therefore, the physical potential is limited by the energy requirements and interest of the end users. In remote regions of northern Canada, the end users are primarily indigenous communities. The integration of geothermal energy into these communities should therefore be guided by the communities' visions for sustainability, autonomy, and sovereignty (Duran et al., 2024). The research project "Geothermal resources for energy transition: Building capacity through engagement with northern communities" was developed to better understand communities interests and concerns about the integration of geothermal energy into their energy budgets (Friser et al., 2024). This research took place in the communities of Burwash Landing, Yukon; Fort Simpson, Northwest Territories; and Kuujjuaq, Nunavik. Each community is unique, but some parallels were able to be drawn across these communities that provide a baseline to guide future energy research projects.

The primary recurring message across the three communities was two-fold:

1. Most community members are open to geothermal energy but did not feel sufficiently knowledgeable to discuss it as an option when considering their energy plans.

2. The communities in Burwash Landing and Fort Simpson would like to see demonstration projects in northern communities as a point of reference. They would like to see tangible advancements in the installation of these systems to better visualize feasible options in northern climates. In Kuujjuaq, a shallow heat-pump system was being installed at the time of the interviews and the presence of this project increased confidence in the technology across interviewees.

The response to this feedback was, in turn, two-fold:

1. The development of a geothermal energy short course designed for northern communities.

2. Research should focus on the feasibility of different geothermal technologies in arctic and sub-arctic climates to support community-led demonstration projects.

4 MOVING FORWARD: FROM FUNDAMENTAL RESEARCH TO COMMUNITY-DRIVEN RESEARCH AND DEVELOPMENT

Fundamental research provides baseline knowledge essential for the development of geothermal systems. However, knowledge-sharing and the development of demonstration projects have been highlighted as the next steps to continue to advance geothermal research in northern Canada in conjunction with local Indigenous communities.

4.1 Geothermal Short Course for Communities

INRS received funding through Natural Resource Canada's GEM-GeoNorth program to develop a geothermal short course to be offered in communities in 2026 and 2027. The short course is designed as educational material to empower communities to bring geothermal energy to the table during energy planning discussions. It is divided into four modules that will provide fundamental knowledge related to geothermal energy and current

technologies, examples of current projects in northern Canada and Scandinavia, and resources that outline local legislation, capacity requirements, and funding opportunities. A modified version of the short course will be offered to schools during the same visit. Researchers will aim to spend time in each community to gain a basic understanding of community's priorities and the current energy context prior to offering the training course.

4.2 On Going Community Projects

4.2.1 Kuujjuaq: Ground-Coupled Heat Pump

The longstanding research in Kuujjuaq (section 2.1) has led to the development of a first pilot ground-coupled heat pump project in Nunavik. The single borehole system is installed in the Kuujjuaq Forum, a community building with a sport complex, and provides sufficient energy to heat and cool offices on the second floor.

Société Kuujjuamiut Inc. led this project supported by INRS and Induktion Géothermie. Induktion installed a 168 m U-loop in the borehole previously drilled for research. The temperature profile along the borehole and thermal conductivity for 15 representative core samples were measured (Miranda and Raymond, 2022). The corrected temperature gradient is 19.7 ºC km^{-1} and the thermal conductivity ranged from 2.5 to 3.1 W m^{-1} K^{-1} (Léveillée-Dallaire & Raymond, submitted). The system started operating in August 2025 (Figure 3). The system will be monitored to evaluate the efficiency of the heat pump. Kuujjuamiut Inc. will then collaborate with partners to analyze the system performance and impacts over time. This follow-up will provide valuable information for future systems in subarctic Canada, notably for communities located on the Canadian Shield.

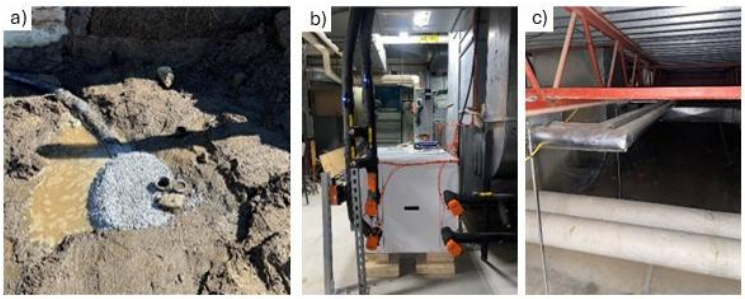


Figure 3: Photos from the Kuujjuaq Forum pilot project: a) the 168 m ground heat exchanger before closing, b) the geothermal heat pump and internal piping, and c) ventilation piping (photo credit: Chloé Pierat)

4.2.2 Dawson City: Surface Water Heat Pump

The City of Dawson has recently installed a surface water heat pump system with the aim to reduce diesel heating for the local recycling plant. The surface water loop is located in placer mining tailing ponds and is expected to be operational by 2026 (S. Lewis, personal communication, 2025).

4.2.3 Village of Mayo: Open-Loop to pre-heat domestic water supply

An open-loop heat exchange system was first installed in the village of Mayo in 1979. The borehole is ~250 m and taps into a 13 to 15 °C artesian aquifer. The system was expanded with a second borehole in 1990. The open-loop extracts water from both boreholes and the outflow is directed into the Mayo River. The energy from the boreholes is used in a passive exchange to increase the temperature of the village's potable water supply to prevent freezing during distribution. Replacement boreholes that tap into the same aquifer were drilled in 2023 (R. Brown, personal communication, 2025).

4.2.4 Burwash Landing: Standing-Column Well

Kluane First Nation drilled a geothermal exploration borehole in 2012. The objective was to drill to 1 km to evaluate the potential for a district heating system, but the drilling was stopped at 387 m. The corrected temperature gradient in the sediments is 47 ºC km^{-1}. In 2024, Kluane First Nation applied for federal funding through CanNor project: Inclusive Diversification and Economic Advancement in the North to repurpose the exploration borehole to meet some of the Lhù' ààn Chù' Shàw-kwa-than Kų' (Kluane Good Water House) heating needs.

This borehole presents three unique challenges:

- Retrofit configuration: As it is a retrofit project, the design approach is inverted relative to a typical installation. The geothermal contribution is constrained by the existing well design rather than being designed based on the heating and cooling loads.

- Permafrost conditions: There is 55 m of active layer underlain by permafrost located entirely in surficial sediments. The ice-content of the permafrost and the porosity of the sediments are low, but the influence of the ground-source heat exchanger on permafrost temperature and integrity must be considered.

- Artesian aquifer: The base of the borehole is in an artesian aquifer. The presence of groundwater flow is beneficial for a standing-column well as it will continue to refresh the available heat. However, incorporating a bleed to enhance the system is not feasible due to the groundwater composition.

A standing-column well design would allow groundwater to be used directly to enhance heat exchange and improve overall system performance. This approach eliminates the need for a second borehole that would otherwise be required for a full open-loop system. This project could represent the first application of a standing-column well in northern Canada. A holistic design approach is therefore critical to address the combined effects of retrofit constraints, permafrost dynamics, and hydrogeological conditions.

4.3 Discussion

Geothermal research across northern Canada continues to evaluate the geothermal potential across communities in Yukon, Northwest Territories, Nunavut, and Nunavik. The fundamental research is essential to understand deep geothermal potential and evaluate which shallow technologies could be implemented on the short-term. Community-led pilot projects are now underway in Kuujjuaq (Nunavik), Dawson City (Yukon), and Burwash Landing (Yukon). These communities are leading the way in the integration of shallow geothermal technologies in northern Canada. These projects will allow for the evaluation of the performance of shallow-geothermal technologies in subarctic climates and will inform further research and development for projects across northern Canada. It is essential that geothermal projects are community led as this ensures that the project is relevant and there is an interest in developing the capacity in the community to operate and repair the system. Local expertise is essential to ensure the longevity of the integration of new technologies into remote regions.

A concern with the use of ground source heat pumps in northern climates is the offset between heating and cooling demand. Research into solar-thermal ground-heat exchangers aimed to mitigate this imbalance by recharging the subsurface with solar energy during summer when the heating demand is low and solar availability is high but have not been deemed economically advantageous due to upfront costs of solar-thermal and energy loss in the subsurface (Giordano & Raymond, 2019; Maranghi et al., 2023). The use of longer heat exchangers and a fan coil to extract heat from the air during summer and reinject this into the ground are believed to be better strategies to deal with load imbalance (Adebayo et al., 2025).

The implementation of ground-source heat pumps will decrease diesel consumption, either for heating or electricity, as compared to domestic oil or baseboard heating, but they still require electricity to operate. To benefit from the reduced emissions associated with a ground-source heat pump, some clean energy must be supplied (Fine et al., 2018; Langevin et al., 2024). Solar-assisted systems use solar photovoltaics to produce electricity used by the ground-source heat pumps and was shown to have significant potential in the North (Gunawan et al., 2020; Maranghi et al., 2023; Moreno et al., 2024).

There are currently no deep geothermal systems operating in northern Canada. However, the St1 Deep Heat Project in Espoo, Finland, demonstrates the technical feasibility of harvesting deep geothermal energy using an enhanced geothermal system in crystalline bedrock and in subarctic climates. The project involved drilling two 6 km deep wells reaching 120 °C for thermal power to district heating (Kukkonen et al., 2022). Hydraulic stimulation was employed to enhance permeability between the injection and production wells, but the hydraulic conductivity of fractured zones was pressure-dependent which limits reservoir performance under normal operating conditions (Kukkonen et al., 2023). The St1 project is not currently active due to poor long-term reservoir performance, primarily related to the limited hydraulic connectivity between the wells (Kukkonen et al., 2024). Communities in Nunavik, Nunavut, and eastern Northwest territories are located on the Canadian Shield and have similar geological conditions. Future deep geothermal projects in these areas should be informed by the lessons learned from the St1 project.

5 CONCLUSIONS

The integration of geothermal energy in Northern Canada offers an opportunity for communities to decrease dependence on fossil fuels, while increasing energy autonomy and sovereignty. Previous geothermal research across northern Canada focused on building a foundation and fill knowledge-gaps unique to subarctic and arctic Canada. Fundamental geothermal research in Nunavik, Nunavut, Northwest Territories, and Yukon, has built a foundation for future development. Community members from Burwash Landing (Yukon), Fort Simpson

(Northwest Territories), and Kuujjuaq (Nunavik) highlighted the need for capacity building and pilot projects. Capacity building should aim to empower community members and administration to feel comfortable bringing geothermal into the discussions regarding local energy plans, whereas pilot projects in subarctic and arctic Canada would build confidence in the technology through demonstration. However, pilot projects must be co-developed with community. Researchers should prioritize collaboration with community to ensure further studies are aligned with community goals and expectations. Irrespective of physical potential, geothermal projects success in northern Canada can only succeed in communities with an interest to develop and maintain the resource.

Acknowledgements

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REFERENCES

Adebayo, P., Jathunge, C. B., Fry, N., Shor, R., Mohamad, A., & Mwesigye, A. (2025). Long-Term Performance Analysis of Foundation Pile and Vertical Borehole Heat Exchangers for Ground Source Heat Pump Systems in Cold Climates. *Energy Science & Engineering*, *13*(10), 4810–4824. https://doi.org/10.1002/ese3.70209

Arriaga, M., Brooks, M., & Moore, N. (2017). *Energy access—The Canadian context* (Waterloo Global Science Initiative's, p. 6) [OpenAcess Energy Blueprint].

Bacon, Y. (2026). *Geothermal Potential in Baker Lake, Nunavut: Research to support enhanced geothermal systems in Northern remote communities* (p. 25). Cascade Institut. https://doi.org/10.5281/zenodo.18378955

Bacon, Y., Miranda, M., Raymond, J., Newson, J., Wigston, A., & Minnick, M. (2024). *The Deep Geothermal Energy Potential of Baker Lake (Nunavut, Canada): Initial Resource Assessment from Monte Carlos Analysis*. Geothermal Rising. https://www.geothermal-library.org/index.php?mode=pubs&action=view&record=1035182

Beranek, L. P., & Mortensen, J. K. (2011). The timing and provenance record of the Late Permian Klondike orogeny in northwestern Canada and arc-continent collision along western North America. *Tectonics*, *30*(5). https://doi.org/10.1029/2010TC002849

Chapman, F. M., Klepikova, M., Bour, O., Miranda, M., Soucy La Roche, R., & Raymond, J. (2025). Heat flux evaluation based on active fiber optic distributed temperature sensing tests in southwestern Yukon, Canada. *Geothermics*, *131*, 103354. https://doi.org/10.1016/j.geothermics.2025.103354

Chapman, F. M., Miranda, M., Roche, R. S. L., & Raymond, J. (2022). *Fracture network analysis in the Duke River area, southwestern Yukon*.

Colpron, M. (2019). *Potential radiogenic heat production from granitoid plutons in Yukon*.

Colpron, M., Crowley, J. L., Gehrels, G., Long, D. G. F., Murphy, D. C., Beranek, L., & Bickerton, L. (2015). Birth of the northern Cordilleran orogen, as recorded by detrital zircons in Jurassic synorogenic strata and regional exhumation in Yukon. *Lithosphere*, *7*(5), 541–562. https://doi.org/10.1130/L451.1

Colpron, M., Hayward, N., & Crowley, J. L. (2021). *Potential heat production from the Seagull and Teslin plutonic suites, southern Yukon: Geochemistry, geochronology, rock physical properties, and 3D geophysical inversion of Bouguer gravity data*.

Comeau, F.-A., Raymond, J., Malo, M., Dezayes, C., & Carreau, M. (2017). *Geothermal Potential of Northern Québec: A Regional Assessment*.

Duran, S., Hrenyk, J., Sahinyazan, F. G., & Salmon, E. (2024). Re-righting renewable energy research with Indigenous communities in Canada. *Journal of Cleaner Production*, *445*, 141264. https://doi.org/10.1016/j.jclepro.2024.141264

Eavor. (2023, April 18). *Eavor named as a key developer for Yukon's geothermal potential and economic future*. https://eavor.com/blog/eavor-named-as-a-key-developer-for-yukons-geothermal-potential-and-economic-future/

EBA Engineering Consultants. (2010). *Geothermal Favourability Map Northwest Territories*.

Elliott, J. L., Larsen, C. F., Freymueller, J. T., & Motyka, R. J. (2010). Tectonic block motion and glacial isostatic adjustment in southeast Alaska and adjacent Canada constrained by GPS measurements. *Journal of Geophysical Research: Solid Earth*, *115*(B9). https://doi.org/10.1029/2009JB007139

Fine, J. P., Nguyen, H. V., Friedman, J., Leong, W. H., & Dworkin, S. B. (2018). A simplified ground thermal response model for analyzing solar-assisted ground source heat pump systems. *Energy Conversion and Management*, *165*, 276–290. https://doi.org/10.1016/j.enconman.2018.03.060

Fraser, T., Colpron, M., & Relf, C. (2019). *Evaluating geothermal potential in Yukon through temperature gradient drilling*.

Friser, A., Chapman, F., Miranda, M. M., Gorcy, D., & Raymond, J. (2024). Capturing the social acceptability of geothermal energy in northern Canada: An interdisciplinary initiative involving communities. *European Exploration Geology Journal*. https://doi.org/10.5281/ZENODO.12205625

George, S. W. M., Nelson, J. L., Alberts, D., Greig, C. J., & Gehrels, G. E. (2021). Triassic–Jurassic Accretionary History and Tectonic Origin of Stikinia From U-Pb Geochronology and Lu-Hf Isotope Analysis, British Columbia. *Tectonics*, *40*(4), e2020TC006505. https://doi.org/10.1029/2020TC006505

Geothermal Canada. (2023, September 5). Exploring the Possibility of Geothermal Energy in Nunavut. *Geothermal Canada*. https://www.geothermalcanada.org/news/2023/9/6/exploring-the-possibility-of-geothermal-energy-in-nunavut

Ghomshei, M. (2007). *Geothermal Energy from Con Mine Heating the City of Yellowknife, NWT: A concept study*. University of British Colombia.

Giordano, N., & Raymond, J. (2019). Alternative and sustainable heat production for drinking water needs in a subarctic climate (Nunavik, Canada): Borehole thermal energy storage to reduce fossil fuel dependency in off-grid communities. *Applied Energy*, *252*, 113463. https://doi.org/10.1016/j.apenergy.2019.113463

Gold, A., Raymond, J., Miranda, M., & Einar Jon, A. (2023). *Minimizing Permafrost Thaw and Maximizing Thermal Heat Storage in Baker Lake, Nunavut* (p. 109) [Final Report]. Institut national de la recherche scientifique.

Grasby, S. E., Allen, D. M., Bell, S., Chen, Z., Ferguson, G., Jessop, A., Kelman, M., Ko, M., Majorowicz, J., Moore, M., Raymond, J., & Therrien, R. (2012). *Geothermal energy resource potential of Canada* (No. 6914; rev., p. 6914). Geological Survey of Canada. https://doi.org/10.4095/291488

Gunawan, E., Giordano, N., Jensson, P., Newson, J., & Raymond, J. (2020). Alternative heating systems for northern remote communities: Techno-economic analysis of ground-coupled heat pumps in Kuujjuaq, Nunavik, Canada. *Renewable Energy*, *147*, 1540–1553. https://doi.org/10.1016/j.renene.2019.09.039

Holm, E. (2023). *Geothermal resources legislation: What We Heard*.

Jessop, A. M., Souther, J. G., Lewis, T. J., & Judge, A. S. (1984). Geothermal measurements in northern British Columbia and southern Yukon Territory. *Canadian Journal of Earth Sciences*, *21*(5), 599–608. https://doi.org/10.1139/e84-064

Kukkonen, I., Heikkinen, P., Sinisaari, M., Rytkönen, J., Karjalainen, A., Malin, P., Giese, R., & Kueck, J. (2022, October 1). *St1 Deep Heat Project: Geothermal energy from 5-6 km in the continental crust*.

Kukkonen, I., Kietäväinen, R., Nenonen, V., Bomberg, M., Miettinen, H., Nyyssönen, M., Nuppunen-Puputti, M., Karjalainen, A., & Rytkönen, J. (2024). Research application of the St1 superdeep boreholes in Espoo, southern Finland: 13th Symposium on Structure, Composition and Evolution of the Lithosphere in Fennoscandia, LITO 2024. *Lithospere 2024, University of Helsinki: Institute of Seismology Report*, 45–46.

Kukkonen, I. T., Heikkinen, P. J., Malin, P. E., Renner, J., Dresen, G., Karjalainen, A., Rytkönen, J., & Solantie, J. (2023). Hydraulic conductivity of the crystalline crust: Insights from hydraulic stimulation and induced seismicity of an enhanced geothermal system pilot reservoir at 6 km depth, Espoo, southern Finland. *Geothermics*, *112*, 102743. https://doi.org/10.1016/j.geothermics.2023.102743

Langevin, H., Giordano, N., Raymond, J., Gosselin, L., & Bourbonnais, M. (2024). Geothermal heat pumps to reduce diesel consumption in an off-grid subarctic community: Comparison of solar assisted systems with optional underground energy storage. *Geothermics*, *116*, 102846. https://doi.org/10.1016/j.geothermics.2023.102846

Léveillée-Dallaire, X., & Raymond, J. (2023). *Hydrothermal modelling of Takhini Hot Springs (NTS 105D/14)*.

Léveillée-Dallaire, X., & Raymond, J. (submitted). *Thermal Conductivity Assessment for Geothermal Potential Evaluation: Forum Well, Kuujjuaq*.

Majorowicz, J. A., & Minea, V. (2015). Shallow and deep geothermal energy potential in low heat flow/cold climate environment: Northern Québec, Canada, case study. *Environmental Earth Sciences*, *74*(6), 5233–5244. https://doi.org/10.1007/s12665-015-4533-1

Mandemvo, D., Comeau, F.-A., Raymond, J., Grasby, S., & Terlaky, V. (2023). Geothermal Potential of Closed Underground Mines: Resource Assessment Study of the Con Mine, Northwest Territories, Canada. *Natural Resources Research*, *32*. https://doi.org/10.1007/s11053-023-10214-3

Mandemvo, D. D. N., Comeau, F.-A., Raymond, J., Grasby, S. E., & Terlaky, V. (2024). Numerical Assessment of the Geothermal and Thermal Energy Storage Potential of the Underground Con Mine (Northwest Territories, Canada). *Mine Water and the Environment*, *43*(1), 148–167. https://doi.org/10.1007/s10230-024-00976-4

Maranghi, F., Gosselin, L., Raymond, J., & Bourbonnais, M. (2023). Modeling of solar-assisted ground-coupled heat pumps with or without batteries in remote high north communities. *Renewable Energy*, *207*, 484–498. https://doi.org/10.1016/j.renene.2023.03.040

Minnick, M., Schewfelt, D., Hickson, C., Majorowicz, J., & Rowe, T. (2018). *Nunavut Geothermal Feasibility Study* (Topical Report RSI-2828; p. 42). RESPEC Consulting Inc.

Miranda, M. A., & Raymond, J. (2022). *Assessing Kuujjuaq's (Nunavik, Canada) deep geothermal potential: Core analysis, thermal properties characterization and surface heat flux estimation of a 234 m deep geothermal exploration well* [Final Report]. Institut national de la recherche scientifique, Centre Eau Terre Environnement.

Miranda, M., Chapman, F., Bacon, Y., & Raymond, J. (2025). *Heat flow assessment in the Yukon Territory*.

Miranda, M., Comeau, F.-A., Raymond, J., Gosselin, L., Grasby, S. E., Wigston, A., Dehghani-Sanij, A., Sternbergh, S., & Perreault, S. (2022). Geothermal resources for energy transition: A review of research undertaken for remote northern Canadian communities. *European Geologist*, *54*.

Miranda, M. M., Bacon, Y., & Raymond, J. (2023). *Deep geothermal energy potential of Baker Lake (Nunavut, Canada)*. Institut national de la recherche scientifique.

Miranda, M. M., Raymond, J., & Dezayes, C. (2020). Uncertainty and Risk Evaluation of Deep Geothermal Energy Source for Heat Production and Electricity Generation in Remote Northern Regions. *Energies*, *13*(16), 4221. https://doi.org/10.3390/en13164221

Miranda, M., Raymond, J., Willis-Richards, J., & Dezayes, C. (2021). Are Engineered Geothermal Energy Systems a Viable Solution for Arctic Off-Grid Communities? A Techno-Economic Study. *Water*, *13*(24), 3526. https://doi.org/10.3390/w13243526

Moreno, D., Raymond, J., & Gosselin, L. (2024). Techno-economic analysis of hybrid solar-assisted geothermal and biomass heating systems in remote subarctic communities (Nunavik, Canada). *Energy*, *313*, 133898. https://doi.org/10.1016/j.energy.2024.133898

Natural Resources Canada. (2025, September 12). *Indigenous-Owned Wind Power Strengthens Energy Security in the North* [News releases]. https://www.canada.ca/en/natural-resources-canada/news/2025/09/indigenous-owned-wind-power-strengthens-energy-security-in-the-north.html

Newton, S. (2025). Characterizing the Ground Thermal Conductivity of Whitehorse, Yukon. *Research Proposal*.

Pinto, T. F., & Enkelmann, E. (2025). *Thermal History of the Liard Basin in Northern British Columbia and Western Northwest Territories (NTS 095B, 095C, 094J, 094K and 094N)* (Nos 2025–01; Geoscience BC Sum Mary of Activities 2024, pp. 75–82). Geoscience BC.

Rajaobelison, M., Thibault, M., Comeau, F.-A., Raymond, J., Smejkal, E., & Terlaky, V. (2024). Thermostratigraphic and Heat Flow Assessment of the South Slave Region in the Northwest Territories, Canada. *Energies*, *17*(16), 4165. https://doi.org/10.3390/en17164165

Sternbergh, S. K., & Colpron, M. (2025). Summary of geothermal indicators in Yukon. *Yukon Geological Survey*, *Open File 2025-7*, 92.

Thibault, M., Comeau, F.-A., Raymond, J., Rajaobelison, M., Terlaky, V., & Newson, J. (2024). Evaluation of the Precambrian Basement Temperature Below Four South Slave Communities, Northwest Territories, Canada. *GRC Transactions*, *48*. https://scholar.google.com/citations?view_op=view_citation&hl=fr&user=KXWF23QAAAAJ&citation_for_view=KXWF23QAAAAJ:d1gkVwhDpl0C

Tschirhart, V., Colpron, M., Craven, J., Ghalati, F. H., Enkin, R. J., & Grasby, S. E. (2022). Geothermal Exploration in the Burwash Landing Region, Canada, Using Three-Dimensional Inversion of Passive Electromagnetic Data. *Remote Sensing*, *14*(23), 5963. https://doi.org/10.3390/rs14235963

Witter, J. B. (2020). *Early-stage exploration for geothermal energy resources along the Denali fault near Duke River, Yukon*.

Witter, J. B. (2022). *Analysis of geoscience data for geothermal exploration along the Tintina fault near Watson Lake, Yukon* (Open File Nos 2022–8; p. 50). Yukon Geological Survey.

Witter, J. B. (2023). *Analysis of geoscience data for geothermal exploration along the Teslin fault near Teslin, Yukon* (Open File Nos 2023–3; p. 48). Yukon Geological Survey.

Witter, J. B., Miller, C. A., Friend, M., & Colpron, M. (2018). *Curie Point Depths and Heat Production in Yukon, Canada*. 43rd Workshop on Geothermal Reservoir Engineering.

Wu, X., Sameti, M., Nasiri, F., & Li, B. (2024). An off-grid solar district energy system with borehole thermal energy storage: Life cycle assessment in a subarctic region. *Journal of Building Engineering*, *91*, 109576. https://doi.org/10.1016/j.jobe.2024.109576

Yukon Government. (2020). *Our Clean Future: A Yukon strategy for climate change, energy and a green economy*.